

Application No. 10/500,858  
Marked-up of Amended Claims and Abstract

### CLAIMS

1 (Currently Amended): A nonlinear resistor circuit using a floating gate MOSFETs, wherein a  $\Lambda$ -shaped nonlinear resistor circuit using a multi-input floating gate MOSFET and a V-shaped nonlinear resistor circuit using a multi-input floating gate MOSFET are connected in parallel therewith and current of said  $\Lambda$ -shaped nonlinear resistor circuit and current of said V-shaped nonlinear resistor circuit are added, thus to combine various N-shaped voltage-current characteristics, said N-shaped voltage-current characteristic is continuously changed, and the voltage-current characteristics approximate to piecewise linear characteristics of third to seventh orders are realized.

2 (Canceled).

3 (Canceled).

4 (Currently Amended): The nonlinear resistor circuit using the floating gate MOSFETs according to Claim [[1]] 3, wherein negative resistor portions in the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are linear as much as possible, and both the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are moved in parallel in the left and right directions by a voltage between an input terminal of said  $\Lambda$ -shaped nonlinear resistor circuit and a drain terminal of an N-channel MOSFET and a voltage between an input terminal of said V-shaped nonlinear resistor circuit and a drain terminal of a P-channel MOSFET, thus to combine the characteristic of the third order.

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5 (Currently Amended): The nonlinear resistor circuit using the floating gate MOSFETs according to Claim [[1]] 3, wherein negative resistor portions in the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are linear as much as possible, and both the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are moved in parallel in the left and right directions by a voltage between the ground and a drain terminal of a floating gate P-channel MOSFET of said  $\Lambda$ -shaped nonlinear resistor circuit and a voltage between the ground and a drain terminal of a floating gate N-channel MOSFET of said V-shaped nonlinear resistor circuit, thus to combine the characteristic of the third order.

6 (Currently Amended): The nonlinear resistor circuit using the floating gate MOSFETs according to Claim [[1]] 3, wherein an inclination of a negative portion of the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit or the voltage-current characteristic of said V-shaped nonlinear resistor circuit is adjusted to change the inclination of the characteristic, and the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit or the voltage-current characteristic of said V-shaped nonlinear resistor circuit is moved in parallel in the left and right directions by a voltage between an input terminal of said  $\Lambda$ -shaped nonlinear resistor circuit and a drain terminal of an N-channel MOSFET and a voltage between an input terminal of said V-shaped nonlinear resistor circuit and a drain terminal of a P-channel MOSFET, thus to combine the fourth order characteristic.

7 (Currently Amended): The nonlinear resistor circuit using the floating gate MOSFETs according to Claim [[1]] 3, wherein an inclination of a negative portion of the

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voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit or the voltage-current characteristic of said V-shaped nonlinear resistor circuit is adjusted to change the inclination of the characteristic, and the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit or the voltage-current characteristic of said V-shaped nonlinear resistor circuit is moved in parallel in the left and right directions by a voltage between the ground and a drain terminal of a floating gate P-channel MOSFET of said  $\Lambda$ -shaped nonlinear resistor circuit and a voltage between the ground and a drain terminal of a floating gate N-channel MOSFET of said V-shaped nonlinear resistor circuit, thus to combine the fourth order characteristic.

8 (Currently Amended): The nonlinear resistor circuit using the floating gate MOSFETs according to Claim [[1]] 3, wherein inclinations of negative portions of both the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are adjusted to change the inclinations of the characteristics, and both the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are moved in parallel in the left and right directions by a voltage between an input terminal of said  $\Lambda$ -shaped nonlinear resistor circuit and a drain terminal of an N-channel MOSFET and a voltage between an input terminal of said V-shaped nonlinear resistor circuit and a drain terminal of a P-channel MOSFET, thus to combine the fifth order characteristic.

9 (Currently Amended): The nonlinear resistor circuit using the floating gate MOSFETs according to Claim [[1]] 3, wherein inclinations of negative portions of both the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit and the voltage-

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current characteristic of said V-shaped nonlinear resistor circuit are adjusted to change the inclinations of the characteristics, and both the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are moved in parallel in the left and right directions by a voltage between the ground and a drain terminal of a floating gate P-channel MOSFET of said  $\Lambda$ -shaped nonlinear resistor circuit and a voltage between the ground and a drain terminal of a floating gate N-channel MOSFET of said V-shaped nonlinear resistor circuit, thus to combine the fifth order characteristic.

10 (Currently Amended): The nonlinear resistor circuit using the floating gate MOSFETs according to Claim [[1]] 3, wherein an inclination of a negative portion of the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit or the voltage-current characteristic of said V-shaped nonlinear resistor circuit is adjusted to change the inclination of the characteristic, and both the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are moved in parallel in the lateral axis direction by a voltage between an input terminal of said  $\Lambda$ -shaped nonlinear resistor circuit and a drain terminal of an N-channel MOSFET and a voltage between an input terminal of said V-shaped nonlinear resistor circuit and a drain terminal of a P-channel MOSFET, thus to combine the sixth order characteristic.

11 (Currently Amended): The nonlinear resistor circuit using the floating gate MOSFETs according to Claim [[1]] 3, wherein an inclination of a negative portion of the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit or the voltage-current characteristic of said V-shaped nonlinear resistor circuit is adjusted to change the inclination of the characteristic, and both the voltage-current characteristic of said  $\Lambda$ -shaped

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nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are moved in parallel in the lateral axis direction by a voltage between the ground and a drain terminal of a floating gate P-channel MOSFET of said  $\Lambda$ -shaped nonlinear resistor circuit and a voltage between the ground and a drain terminal of a floating gate N-channel MOSFET of said V-shaped nonlinear resistor circuit, thus to combine the sixth order characteristic.

12 (Currently Amended): The nonlinear resistor circuit using the floating gate MOSFETs according to Claim [[1]] 3, wherein inclinations of negative portions of both the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are adjusted to change the inclinations of the characteristics, and both the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are moved in parallel in the lateral axis direction by a voltage between an input terminal of said  $\Lambda$ -shaped nonlinear resistor circuit and a drain terminal of an N-channel MOSFET and a voltage between an input terminal of said V-shaped nonlinear resistor circuit and a drain terminal of a P-channel MOSFET, thus to combine the seventh order characteristic.

13 (Currently Amended): The nonlinear resistor circuit using the floating gate MOSFETs according to Claim [[1]] 3, wherein inclinations of negative portions of both the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are adjusted to change the inclinations of the characteristics, and both the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear

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resistor circuit are moved in parallel in the lateral axis direction by a voltage between the ground and a drain terminal of a floating gate P-channel MOSFET of said  $\Lambda$ -shaped nonlinear resistor circuit and a voltage between the ground and a drain terminal of a floating gate N-channel MOSFET of said V-shaped nonlinear resistor circuit, thus to combine the seventh order characteristic.

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## CLAIMS

1. A nonlinear resistor circuit using a floating gate MOSFETs, wherein a  $\Lambda$ -shaped nonlinear resistor circuit using a multi-input floating gate MOSFET and a V-shaped nonlinear resistor circuit using a multi-input floating gate MOSFET are connected in parallel therewith and current of said  $\Lambda$ -shaped nonlinear resistor circuit and current of said V-shaped nonlinear resistor circuit are added, thus to combine various N-shaped voltage-current characteristics.
2. The nonlinear resistor circuit using the floating gate MOSFETs according to Claim 1, wherein said N-shaped voltage-current characteristic is continuously changed.
3. The nonlinear resistor circuit using the floating gate MOSFETs according to Claim 2, wherein the voltage-current characteristics approximate to piecewise linear characteristics of third to seventh orders are realized.
4. The nonlinear resistor circuit using the floating gate MOSFETs according to Claim 3, wherein negative resistor portions in the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit and in the voltage-current characteristic of said V-shaped nonlinear resistor circuit are linear as much as possible, and both the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped

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nonlinear resistor circuit are moved in parallel in the left and right directions by a voltage between an input terminal of said A-shaped nonlinear resistor circuit and a drain terminal of an N-channel MOSFET and a voltage between an input terminal of said V-shaped nonlinear resistor circuit and a drain terminal of a P-channel MOSFET, thus to combine the characteristic of the third order.

5. The nonlinear resistor circuit using the floating gate MOSFETs according to Claim 3, wherein negative resistor portions in the voltage-current characteristic of said A-shaped nonlinear resistor circuit and in the voltage-current characteristic of said V-shaped nonlinear resistor circuit are linear as much as possible, and both the voltage-current characteristic of said A-shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are moved in parallel in the left and right directions by a voltage between the ground and a drain terminal of a floating gate P-channel MOSFET of said A-shaped nonlinear resistor circuit and a voltage between the ground and a drain terminal of a floating gate N-channel MOSFET of said V-shaped nonlinear resistor circuit, thus to combine the characteristic of the third order.

6. The nonlinear resistor circuit using the floating gate MOSFETs according to Claim 3, wherein an inclination of a negative portion of the voltage-current characteristic of



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said  $\Lambda$ -shaped nonlinear resistor circuit or the voltage-current characteristic of said V-shaped nonlinear resistor circuit is adjusted to change the inclination of the characteristic, and the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit or the voltage-current characteristic of said V-shaped nonlinear resistor circuit is moved in parallel in the left and right directions by a voltage between an input terminal of said  $\Lambda$ -shaped nonlinear resistor circuit and a drain terminal of an N-channel MOSFET and a voltage between an input terminal of said V-shaped nonlinear resistor circuit and a drain terminal of a P-channel MOSFET, thus to combine the fourth order characteristic.

7. The nonlinear resistor circuit using the floating gate MOSFETs according to Claim 3, wherein an inclination of a negative portion of the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit or the voltage-current characteristic of said V-shaped nonlinear resistor circuit is adjusted to change the inclination of the characteristic, and the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit or the voltage-current characteristic of said V-shaped nonlinear resistor circuit is moved in parallel in the left and right directions by a voltage between the ground and a drain terminal of a floating gate P-channel MOSFET of said  $\Lambda$ -

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shaped nonlinear resistor circuit and a voltage between the ground and a drain terminal of a floating gate N-channel MOSFET of said V-shaped nonlinear resistor circuit, thus to combine the fourth order characteristic.

8. The nonlinear resistor circuit using the floating gate MOSFETs according to Claim 3, wherein inclinations of negative portions of both the voltage-current characteristic of said A-shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are adjusted to change the inclinations of the characteristics, and both the voltage-current characteristic of said A-shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are moved in parallel in the left and right directions by a voltage between an input terminal of said A-shaped nonlinear resistor circuit and a drain terminal of an N-channel MOSFET and a voltage between an input terminal of said V-shaped nonlinear resistor circuit and a drain terminal of a P-channel MOSFET, thus to combine the fifth order characteristic.

9. The nonlinear resistor circuit using the floating gate MOSFETs according to Claim 3, wherein inclinations of negative portions of both the voltage-current characteristic of said A-shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor

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circuit are adjusted to change the inclinations of the characteristics, and both the voltage-current characteristic of said A-shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are moved in parallel in the left and right directions by a voltage between the ground and a drain terminal of a floating gate P-channel MOSFET of said A-shaped nonlinear resistor circuit and a voltage between the ground and a drain terminal of a floating gate N-channel MOSFET of said V-shaped nonlinear resistor circuit, thus to combine the fifth order characteristic.

10. The nonlinear resistor circuit using the floating gate MOSFETs according to Claim 3, wherein an inclination of a negative portion of the voltage-current characteristic of said A-shaped nonlinear resistor circuit or the voltage-current characteristic of said V-shaped nonlinear resistor circuit is adjusted to change the inclination of the characteristic, and both the voltage-current characteristic of said A-shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are moved in parallel in the lateral axis direction by a voltage between an input terminal of said A-shaped nonlinear resistor circuit and a drain terminal of an N-channel MOSFET and a voltage between an input terminal of said V-shaped nonlinear resistor circuit and a drain

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terminal of a P-channel MOSFET, thus to combine the sixth order characteristic.

11. The nonlinear resistor circuit using the floating gate MOSFETs according to Claim 3, wherein an inclination of a negative portion of the voltage-current characteristic of said A-shaped nonlinear resistor circuit or the voltage-current characteristic of said V-shaped nonlinear resistor circuit is adjusted to change the inclination of the characteristic, and both the voltage-current characteristic of said A-shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are moved in parallel in the lateral axis direction by a voltage between the ground and a drain terminal of a floating gate P-channel MOSFET of said A-shaped nonlinear resistor circuit and a voltage between the ground and a drain terminal of a floating gate N-channel MOSFET of said V-shaped nonlinear resistor circuit, thus to combine the sixth order characteristic.

12. The nonlinear resistor circuit using the floating gate MOSFETs according to Claim 3, wherein inclinations of negative portions of both the voltage-current characteristic of said A-shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are adjusted to change the inclinations of the characteristics, and both the voltage-current characteristic

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of said  $\Lambda$ -shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are moved in parallel in the lateral axis direction by a voltage between an input terminal of said  $\Lambda$ -shaped nonlinear resistor circuit and a drain terminal of an N-channel MOSFET and a voltage between an input terminal of said V-shaped nonlinear resistor circuit and a drain terminal of a P-channel MOSFET, thus to combine the seventh order characteristic.

13. The nonlinear resistor circuit using the floating gate MOSFETs according to Claim 3, wherein inclinations of negative portions of both the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are adjusted to change the inclinations of the characteristics, and both the voltage-current characteristic of said  $\Lambda$ -shaped nonlinear resistor circuit and the voltage-current characteristic of said V-shaped nonlinear resistor circuit are moved in parallel in the lateral axis direction by a voltage between the ground and a drain terminal of a floating gate P-channel MOSFET of said  $\Lambda$ -shaped nonlinear resistor circuit and a voltage between the ground and a drain terminal of a floating gate N-channel MOSFET of said V-shaped nonlinear resistor circuit, thus to combine the seventh order characteristic.